Taking the whole period from Gledhill's first observation on November 14, 1869, when the spot was central at about 10h. 50m., to one obtained at Bristol on June 7 last, at 9h. 20m., we shall find the interval covered 10,431 days 22 hours and 30 minutes, and that 25,218 rotations were performed with a mean period of 9h. 55m. 37·7s.

In addition to the variation exhibited in the diagram, there have been some minor changes in the motion of the spot. These could, however, only be satisfactorily worked out from the most accurate observations and by determining the rotation periods for short intervals.

As to the question whether the red spot is identical with markings seen in 1857, 1858 and 1859, the matter is open to doubt, for there seems to be a great lack of corroborative observations between 1860 and 1869. The objects delineated by several skilled observers about forty years ago were somewhat similar in position and form to the red spot of recent years, and afford strong presumptive evidence of identity. We have had the spot continuously before us for twenty years, and there can be no doubt that its existence can be traced back to 1869. We ought to be able to go back another ten years and affiliate it with the elliptical markings which were drawn by Dawes, Huggins and others in the region immediately south of the great equatorial belt in 1857, 1858 and 1859, but there is an absence of suitable observations along the interval, and though it is easy to infer that the various objects were identical the fact cannot be demonstrated.

Had observations been more numerous, we should perhaps be able to put our hands on a complete series of records of the red spot extending back for a very long period. It must be remembered that some years ago the planet was so much neglected that a conspicuous feature might easily escape notice during the whole of a favourable apparition. Thus the ellipse of 1869–70 was only seen by Gledhill and Mayer, though Jupiter was a splendid object at about that period. The fact that an object was not seen is, therefore, far from being conclusive evidence of its non-existence.

Though there is reasonable proof that the marking drawn by Russell and Bredichin in 1876 was the same as that which attracted so much notice two years later, it is curious what became of it in 1877. Bredichin gives fifteen drawings of the planet's appearance in the summer of the latter year (see *Annales de l'Observatoire de Moscou*, vol. iv., 1878), but there is no sign of the red spot. The object, if it existed during that opposition, may have been temporarily obscured by more highly reflective material lying above it. It seems to have been much involved with the belts in the southern hemisphere before 1878. Mr. H. C. Russell remarks that he first saw it separated from the belts on July 8, 1878, and was not long in recognising it as an old friend which he had frequently seen in 1876.

Many of the markings on Jupiter are probably formed by materials evolved from the actual surface of the planet, which afterwards become floating masses in the outer region of the atmosphere. Their longitudes do not probably long coincide with that of the original seat of disturbance, for they will fail to keep pace with the exceedingly rapid motion of the sphere, and must exhibit a retardation similar to that so well pronounced in the case of the red spot. The latter has proved itself a very special object with a durableness which does not seem to have characterised other markings. There were "new red spots" in 1886 and 1891, but they did not last long. The majority of the Jovian markings appear to be somewhat transient and irregular in their apparitions, and certain zones of the planet would seem favourable to the production of markings having an individuality of aspect.

The true rotation period of the actual sphere of Jupiter still awaits accurate determination. An occasion might, however, present itself for this element to receive satisfactory investigation. If the spots are really due to eruptions from the planet, and if these should be sustained over periods sufficiently long for the purpose intended, then a string of spots might be formed along a zone, and the time taken to complete the circumference might give data for ascertaining the true rotation period if the retardation of the markings on arriving in the outer atmosphere were allowed for. Thus, in 1880-81 I watched the formation of a complete girdle of spots in about ninety days; and had the distension taken place always on the preceding side, the materials would have been obtained for finding the correct period, for the observed rotation of the spots was 9h. 48m. But the objects appeared to extend themselves both east and west, though the spreading out on the following side may have been due to an increase in the slackening motion, rather than to the formation of new spots. Phenomena of this character obviously offer important features for discussion. Whenever an outbreak of spots takes place, it becomes necessary to learn the direction and rate of its longitudinal distension; for such inquiries may usefully increase our knowledge of the physical condition of Jupiter, and supply us with a more precise value for the rotation period. Our previous acquaintance with this element depends upon atmospheric phenomena, and must be to some extent in error, for the markings display proper motions differing among themselves to the extent of nearly eight minutes, and in nearly every case the rate of velocity appears to vary in an irregular manner but generally lengthening with the time

W. F. DENNING.

THE GERMINATION OF HORDEUM VULGARE.[1]

THE work described in this paper is a continuation of a previous research by Mr. Horace T. Brown and Dr. G. H. Morris published in 1890 (*Jour. Chem. Soc.*, vol. lvii. p. 458), dealing with the respective influences of embryo and endosperm in the alteration of the reserve-starch and cellulose for the requirements of the young plant during germination of seeds of the *Gramineæ*. The seeds of various species were examined, but the main results were obtained with *Hordeum vulgare*; the observations made in this later work are also almost entirely confined to this species, and there can be but little doubt that the results will be found applicable to the *Gramineæ* generally.

It was shown in the earlier paper that the first changes in the endosperm during incipient germination are disintegration and ultimate dissolution of the membranes of the amyliferous cells, this being followed by erosion of the contained starch-granules. These phenomena suggested that the action is due to the influence of the embryo, and not to any autonomous action of the endospermous cells themselves.

While investigating this point, it was found that a carefully excised embryo can exist independently of the seed, if supplied with suitable artificial nutriment in the form of certain carbohydrates, its own proteids yielding sufficient nitrogen for the production of plantlets of considerable size. It was also found that the embryo can be transferred from the endosperm of one seed to that of another, and that healthy plantlets are produced under these artificial conditions.

In this manner it was shown that an excised embryo can induce in starch-granules an action alike in kind and degree to that produced by an embryo growing *in situ* on its natural endosperm, as in normal germination. It was found that the columnar epithele of the scutellum can secrete a very active amylohydrolytic enzyme, and project this into the endosperm or any artificial nutriment in intimate contact with itself. This embryonic activity was, however, recognised not to exclude the possibility that the endospermous cells might participate in the dissolution of their own reserve-materials. To ascertain how far such co-operation might exist, degermed seeds were studied when placed in conditions allowing rapid removal of any products of change. The same end was also obtained by grafting a living embryo from one grain on to the endosperm of another, that had been so treated, so as to destroy presumably all potential vitality of the endospermous cells. Since living embryos induced in these supposititiously dead endosperms all normal changes of depletion, and since no autonomonous changes were observed in the degermed endosperms not attributable at that time to adventitious micro-organisms, the idea of residual vitality in the endosperm as a condition of its depletion seemed superfluous.

Since 1890, Grüss, Hansteen, and others, have confirmed the conclusions formed in 1890, that the embryo can secrete enzymes, but Pfeffer, Hansteen, Grüss, and Puriewitsch have strongly contested the view that the endosperm has no autonomous power of self-depletion. These latter observers state that the amyliferous cells of the endosperm have distinct power of digesting their own reserves, this function being quite independent of any induced action of the embryo, and due to residual vitality.

The present work is the result of a re-examination of the mutual dependence of embryo and endosperm in *Hordeum vulgare.* In it the proportionate shares taken in the endospermous depletion are evaluated for (1) the embryo, (2) the amyliferous part of the endosperm, (3) the so-called "aleurone-layer" (*Kleberschicht*). The possibility of some of the changes being due to enzymes pre-existent in the seeds is considered, as also of any action being due to micro-organisms in experiments with degermed endosperms. The conclusions are drawn from results given by very many experiments in widely-varied conditions.

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[1] "On the Depletion of the Endosperm of *Hordeum vulgare* during Germination." By Horace T. Brown, F.R.S., and F. Escombe. (Read before the Royal Society on March 3.)

Great difficulty was found in the just appreciation of the effects of micro-organisms, for, although their influence on intact seeds is minimal, yet their action on the endosperm bared through degermation produces changes in the cells hardly distinguishable from such as would be induced by the cells themselves, on the assumption that they had living contents.

No antiseptic reagent could be found with such differential action as to inhibit, or materially retard, the growth of micro-organisms, while not hindering normal development of the seedling. But extreme refinements for avoiding air-sown organisms are useless, since complete initial sterilisation of the exterior of the grain cannot be ensured. Differentiation of autonomous action of the tissues from that of extraneous organisms was much aided through study of the action of similar organisms on undoubtedly dead tissue.

To ascertain the self-depletive power of endosperms from which the embryo had been removed, a method was adopted almost identical with that described in the paper of 1890 (*loc. cit.*). The endosperms were placed with their proximal ends downward in small holes in a very thin mica-raft, which was then floated on water so as to just submerge the endospermous surfaces laid bare through degermation, every facility being thus given for outward diffusion of products of change. This method is preferable to Hansteen's plan of affixing the grains to plaster-columns standing in water. In these conditions slow changes undoubtedly occur in the degermed seeds, these being due neither to influence of micro-organisms, nor to enzymes pre-existent in the grains. The changes are very much slower than those of normal germination, but are of the same order, and are undoubtedly due to autonomous action of some part of the endosperm.

There is firstly a tendency for the "aleurone-layer" to separate from the underlying amyliferous cells through cytohydrolysis of the membranes of the latter. This action commences on the dorsal side of the grain near the apex of the scutellum, extends gradually in well-defined directions, and invades slowly the more deeply-seated parts of the endosperm, producing a partially-mealy consistence of the cell-contents. This cytohydrolysis is followed after some days by a more or less partial erosion of the starch-granules underlying immediately the "aleurone-cells." This erosion is, however, very different from that effected by the embryo through the enzyme secreted by its columnar epithele. The difference between these two modes of erosion is clearly shown in the accompanying prints.

These changes in the degermed seeds are without doubt self-induced, since it is impossible to produce them in endosperms that have been demonstrably killed through submersion in chloroform-water for twenty-four hours. It is also certain that the action is initiated by the "aleurone-layer," and not by any autonomous action of the amyliferous cells, since no such changes can be induced in this portion after deprivation of its "aleurone-layer."

Although the statement made in 1890 that the amyliferous cells possess no self-depletive power, is true, the one affirming that the endosperm as a whole is passive during germination requires correction, since the "aleurone-layer" shares with the embryo in preparing the reserve materials for the seedling.

As an active agent in *amylohydrolysis*, the "aleurone-layer" seems to play a subordinate part to the embryo; its principal function appears to be *cytohydrolytic.* Certainly an embryo grafted on an endosperm, the "aleurone-layer" of which has been killed, cannot induce an action comparable in intensity with that produced through joint action of a living embryo and a living "aleurone-layer." This is not due to deficiency in amylohydrolytic power of the embryo, but to the fact that the embryo has relatively small cytohydrolytic power, so that the action of its diastase, owing to the low diffusibility of the latter, is not effective as long as the membranes of the amyliferous cells are undestroyed.

The view put forward in 1890, that the *whole* endosperm is passive during germination, was mainly founded on experiments in which living embryos had been "grafted" on endosperms previously soaked for several months in strong alcohol, a treatment then believed to ensure complete loss of potential vitality of the "aleurone-layer." Such treatment is now known to be insufficient to destroy with certainty even the potential life of the embryo, for barley-seeds have been germinated that had been continuously soaked in strong alcohol for many weeks, and there is reason to believe that the "aleurone-layer" is even more resistant to adverse conditions than the embryo.

The conclusion that the amyliferous cells are incapable of initiating any changes in themselves as deduced from physiological experiments, is strongly supported by cytological observations. A method is described in the paper by which these cells can be cleared of their closely-packed starch granules, so that the nuclei can be readily discerned. During development of the amyliferous cells of the endosperm their nuclei become extremely deformed, owing to the increasing pressure of the starch-granules, and are very often disintegrated. It is difficult to believe that cells in this condition can functionate, even if there were no confirmatory evidence such as is afforded by the physiological experiments described.

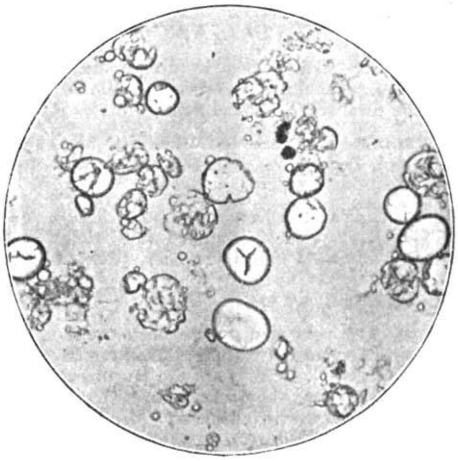

FIG. 1.—Sub-scutellar erosion of starch produced by the embryo. Here the action commences with general *pitting* of the granule. These pits enlarge, and thus break up the granule.

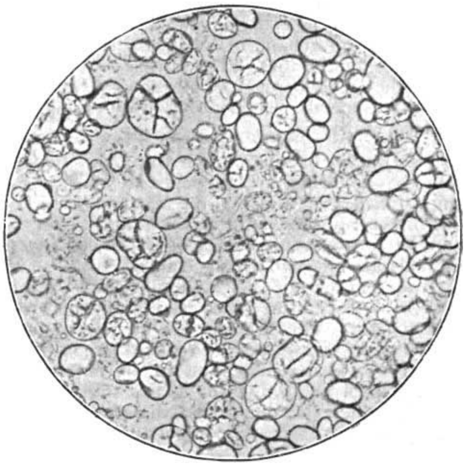

FIG. 2.—"Sub-aleuronic" erosion. Here no preliminary pits are formed, but large *rifts* are produced, and the granule undergoes concentric or irregular dissolution.

It is very probable that the "aleurone-layer" possesses a function additional to that exercised during germination, but which can hardly fail to be very important. Its cells, which undoubtedly contain living elements, constitute the outermost peripheral layer of an otherwise *dead* endosperm, and this would be much more liable to attack by any micro-organisms of the soil which succeeded in penetrating the seed-envelopes, if the protective sheath of living cells were not present. It is remarkable that the "aleurone-layer" is much more fully developed over those parts of the seed that may be regarded as dead, becoming very much more attenuated where in proximity to the embryo, the cells of which owing to their vitality do not require an equal amount of protection.

The authors express, finally, their great thanks to Mr. W. T. Thiselton-Dyer and to Dr. D. H. Scott for the opportunities afforded them in the prosecution of this research at the Jodrell Laboratory, Kew.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

MR. J. CROWTHER, at present lecturer in metallurgy in the Owens College, Manchester, has been appointed to a similar position in the Swansea Technical School.

DR. CHEADLE has presented the St. Mary's Hospital Medical School, Paddington, with the sum of 500*l.*, to found a gold medal in clinical medicine.

DR. WALLACE WALKER has been appointed to the additional chair of Chemistry recently founded and endowed by Mr. W. C. McDonald in M'Gill University, Montreal; and Mr. Ernest Rutherford has been appointed to succeed Prof. H. Callendar in the chair of Physics.

THE following appointments have been made at the West Ham Municipal Technical Institute:—Lecturer in physics and mathematics, Mr. S. G. Starling, of the Battersea Polytechnic; demonstrator in physics, Mr. J. Tomkin, of the Royal College of Science; demonstrator in chemistry, Mr. F. H. Streatfeild, of Finsbury Technical College.

THE *Record of Technical and Secondary Education* for July contains illustrated accounts of the Royal Technical Institute, Salford, and the Leith School of Navigation, and an important article on "Technical Institutions and Local Authorities in England," in which it is endeavoured to give trustworthy information as to the amount of money expended on technical buildings by local authorities. The article deals only with the work done in the county boroughs, but a subsequent contribution will deal with the operations in connection with County Councils and other local authorities.

HER Majesty's Commissioners for the Exhibition of 1851 have made the following appointments to Science Research Scholarships, for the year 1898, on the recommendation of the authorities of the respective Universities and Colleges. The scholarships are of the value of 150*l.* a year, and are ordinarily tenable for two years (subject to a satisfactory report at the end of the first year) in any University at home or abroad, or in some other institution approved of by the Commissioners. The scholars are to devote themselves exclusively to study and research in some branch of science, the extension of which is important to the industries of the country. A limited number of the scholarships are renewed for a third year where it appears that the renewal is likely to result directly in work of scientific importance.

	Nominating institution.	Scholar
1	University of Glasgow	James Francis Bottomley
2	University of Aberdeen	Alexander Findlay
3	Mason University College, Birmingham	A. H. Reginald Buller
4	Yorkshire College, Leeds	Harry Thornton Calvert
5	University College, Liverpool	Ernest Brown
6	University College, London	Louis Napoleon George Filon
7	Owens College, Manchester	James Henry Smith
8	Durham College of Science, Newcastle-upon-Tyne	Arthur William Ashton
9	University College, Nottingham	Austin Henry Peake
10	Royal College of Science for Ireland	Robert L. Wills
11	Queen's College, Galway	Hugh Ryan
12	University of Toronto	William Gabb Smeaton
13	Dalhousie University, Halifax. Nova Scotia	Ebenezer Henry Archibald

The following scholarships, granted in 1897, have been continued for a second year on receipt of a satisfactory report of work done during the first year:—

	Nominating institution	Scholar	Places of study
1	University of Edinburgh	Longfield Smith	University of Leipzig; to proceed to Uuniversity of Heidelberg
2	University of Glasgow	James Muir	Engineering Laboratory, University of Cambridge
3	University of St. Andrews	Harry McDonald Kyle	Gatty Marine Laboratory, St. Andrews, and Laboratoire Arago, Banyuls-sur-mer; to proceed to Marine Laboratory, Heligoland
4	University College, Dundee	Sydney A. Kay	Högskola, Stockholm; to proceed to University of Leipzig
5	Mason College, Birmingham	Gilbert Arden Shakespear	Cavendish Laboratory, University of Cambridge
6	University College, Bristol	Chas. Henry G. Sprankling	Owens College
7	Yorkshire College, Leeds	Harold Albert Wilson	Cavendish Laboratory, University of Cambridge
8	University College, Liverpool	Wm. Augustus Caspari	University of Jena; to proceed to University of Leipzig
9	University College, London	Percy Williams	École de Pharmacie, Paris; to proceed to Prof. Van 't Hoff's Laboratory, Wilmersdorf, Berlin
10	Owens College, Manchester	J. H. Grindley	Owens College (*permitted under special circumstances*)
11	Durham College of Science, Newcastle-upon-Tyne	Robert Railton Hallaway	Universities of Bonn and Heidelberg
12	University College of South Wales and Monmouthshire, Cardiff	Maria Dawson	Botanical Laboratories, University of Cambridge
13	Queen's College, Belfast	W. A. Osborne	University of Tübingen
14	McGill University, Montreal	Jas. Lester Willis Gill	First year, McGill College (*by special permission*); second year, Harvard University
15	Queen's University, Kingston, Ontario	Frederick J. Pope	Columbia University, New York
16	University of Sydney	Tom Percival Strickland	MacDonald Engineering Laboratories, McGill University
17	University of Melbourne	W. Rosenhain	Engineering Laboratory, University of Cambridge

NOTE.—The Report of the Scholar from University College, Nottingham, is not yet due.

The following scholarships, granted in 1896, have been exceptionally renewed for a third year:—

	Nominating institution	Scholar	Places of study
1	Mason College, Birmingham	Thomas Slater Price	University of Leipzig; to proceed to University of Stockholm
2	Yorkshire College, Leeds	Harry Medforth Dawson	Laboratory of Prof. Van 't Hoff, Wilmersdorf, Berlin
3	University College, London	Joseph Ernest Petavel	Davy-Faraday Laboratory
4	University College, Nottingham	George Blackford Bryan	Cavendish Laboratory, Cambridge
5	Dalhousie University, Halifax, Nova Scotia	Douglas McIntosh	Cornell University; to proceed to University of Leipzig

THE Holt Fellowships in Physiology and Pathology established in connection with University College, Liverpool, by the late Mr. George Holt in 1886 for a period of ten years, and renewed for a further period by Mrs. and Miss Holt, have been awarded to the following gentlemen respectively: Mr. A. Hope Simpson, provisionally upon his attaining full qualifications within a period of three months, and Mr. K. Nelson. The Robert Gee Fellowship in Anatomy, of the value of 100*l.*, has been awarded to Mr. F. Lovegrove.